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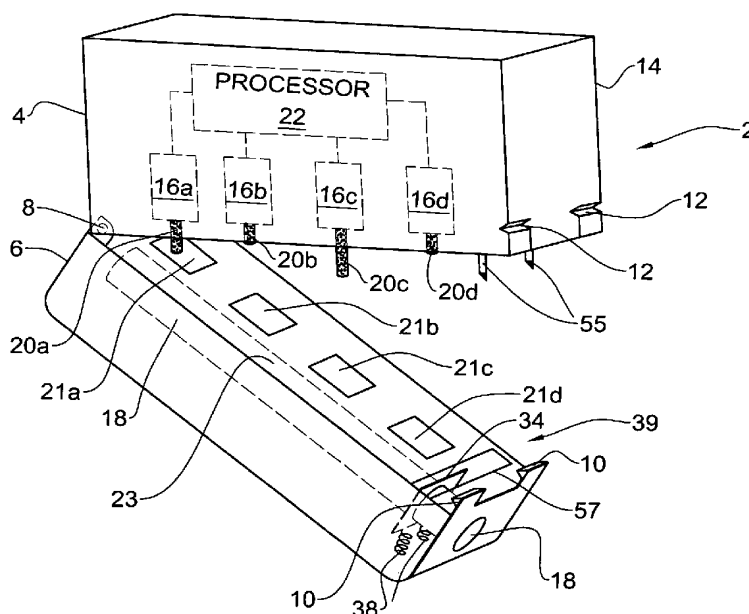
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(54) **Title:** FINGER-TYPE PERISTALTIC PUMP



(57) **Abstract:** The invention provides a finger-type peristaltic pump (2) having a body (4) and a housing (6). The body contains two or more finger-type valves (16) and a processor (22) configured to operate the valves according to a predetermined temporo-spatial pattern. The housing has a passageway (18) configured to receive a conduit. The housing has a first position in which a conduit in the passageway is positioned adjacent to the valve fingers, and a second position in which a conduit in the passageway is not adjacent to the valve fingers. The invention also provides a housing for use in the pump of the invention.



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## FINGER-TYPE PERISTALTIC PUMP

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### FIELD OF THE INVENTION

The present invention relates to pumps and more specifically to finger-type peristaltic pumps.

### BACKGROUND OF THE INVENTION

10 Peristaltic pumps are used for creating a flow of a fluid in an elastic tubular conduit. These pumps have many medical and industrial applications.

In one form of peristaltic pumps, a rotor is used to rotate a plurality of eccentric cams. Each cam, in turn, intermittently collapses the elastic conduit at an initial contact point, and slides along the conduit over a short distance as the  
15 rotor turns. A second cam contacts the initial contact point, and the first cam is then released from the conduit as the second cam slides along the conduit. As this process is repeated, a flow of fluid in the conduit is generated in the direction of the sliding of the cams.

In another form of peristaltic pumps referred to herein as a “*finger-type peristaltic pump*”, a series of valves is aligned along an elastic conduit. Each  
20 valve comprises a “*finger*” that can alternate between two positions. In one position, the finger is extended from the valve so as to contact the conduit and to at least partially occlude the conduit at the point of contact. In the other position, the finger is retracted and does not contact the conduit. The series of valves is  
25 operated according to a temporo-spatial pattern so as to generate a flow in the conduit.

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**SUMMARY OF THE INVENTION**

The present invention provides a finger-type peristaltic pump. The pump of the invention may be used, for example, in a medical context for infusing a liquid into the body of a subject.

5           The peristaltic pump of the invention comprises a housing for holding a segment of an elastic conduit adjacent to the fingers of the valves of the pump. In one embodiment, the housing is hinged at one end to the body of the pump. The housing is swung out from the body in order to introduce a segment of an elastic conduit into the housing. The housing is then swung back towards the  
10   body so as to position the conduit segment adjacent to the fingers of valves of the pump. The housing may be maintained in this closed position by a snapping mechanism, or by a latch.

          In another embodiment, the housing of the invention is detachable from the body of the pump. A segment of a conduit may be introduced into the  
15   housing when the housing is detached. The housing is then attached onto the body of the pump so as to position the segment of the conduit adjacent to the valve fingers. In a most preferred embodiment, the housing is integral with a segment of a conduit. In this case, the conduit in the housing has fittings at each end allowing the conduit to be attached at each end to another piece of conduit,  
20   so that the pump may be integrated into a pumping system. In the detachable housing embodiment, the housing may be disposable.

          The housing of the invention preferably includes an antifree-flow mechanism to prevent the flow of fluid in the segment of the conduit in the housing when the conduit is not adjacent to the fingers. The antifree-flow has a  
25   non-obstructing position in which the antifree-flow device does not prevent flow in the conduit, and an obstructing position in which the antifree-flow device prevents flow in the conduit. The antifree-flow device is spring biased in the obstructing position, so that when the housing is swung away or detached from the body of the pump, the antifree-flow device spontaneously assumes its  
30   obstructing position. This prevents unintentional flow in the conduit when the

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housing is swung out or detached from the body of the pump. The antifree-flow device preferably includes an override mechanism that allows the antifree-flow device to be temporarily latched in its non-obstructing position when the housing is swung away or detached from the body in order to allow a segment of conduit to be introduced into the housing. As the housing is brought to its position in which it is attached to the pump, the antifree-flow device is brought to its unlatched non-obstructing position, regardless of whether it was previously in its obstructing position or its latched non-obstructing position. The antifree flow device may prevent flow in the conduit in both directions or only in one direction.

Thus, in its first aspect, the invention provides a finger-type peristaltic pump comprising a body and a housing, the body containing two or more finger-type valves and a processor configured to operate the valves according to a predetermined temporo-spatial pattern, the housing having a passageway configured to receive a conduit, the housing having a first position in which a conduit in the passageway is positioned adjacent to the valve fingers, and a second position in which a conduit in the passageway is not adjacent to the valve fingers.

In its second aspect, the invention provides a housing for use in the pump of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

**Fig. 1** shows a peristaltic pump having a housing in accordance with one embodiment of the invention;

**Fig. 2** shows the housing of the peristaltic pump of Fig. 1;

**Fig. 3** shows the peristaltic pump of Fig. 1 together with a conduit;

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**Fig. 4** shows an anti free flow device for use in the housing of Fig. 3;

**Fig. 5** shows a peristaltic pump having a housing in accordance with another embodiment of the invention;

**Fig. 6** shows a housing for use in the peristaltic pump of Fig. 5 integral with a conduit; and

**Fig. 7** shows a housing for use in the peristaltic pump of Fig. 5 integral with a conduit and a fluid reservoir.

### DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 shows a finger-type peristaltic pump **2** in accordance with one embodiment of the invention. The pump **2** has a body **4** and a housing **6**. The housing **6** is hinged to the body **4** at a hinge **8** so as to allow the housing **6** to pivot between a closed position shown in Fig. 1a and an open position shown in Fig. 1b. The housing **6** snaps into the closed position by means of projections **10** located at the end of the housing **6** distal to the hinge **8** that snaps into mated notches **12** in the body **4**.

The housing **6** has a passageway **18** dimensioned to receive a segment of an elastic conduit as explained below.

The body **4** has a housing **14** containing a plurality of electrically operated valves **16**. Four valves, **16a** to **16d**, are shown in Fig. 1. This is by way of example only and the pump may have any number of valves **16** greater than two. Each valve **16** has a respective finger **20**. Each valve **16** is electrically operable to oscillate its finger **20** from a retracted position in which the finger **20** does not contact a conduit in the passageway **18** and an extended position in which the finger **20** at least partially occludes a flexible conduit in the passageway **18**. The fingers **20b** and **20d** are shown in Fig. 1 in their retracted position, while the fingers **20a** and **20c** are shown in Fig. 1 in their extended position. Each finger **20** corresponds to a finger hole **21** in the upper surface **23** of the housing **6**. A finger **16**, when in its extended position, extends through its respective finger

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hole 20 into the housing 6 to compress a region of a conduit in the passageway 18.

The body 4 also contains a processor 22 configured to operate the valves 16 according to a temporo-spatial pattern so as to generate a flow of fluid in an elastic conduit in the passageway 18 when the housing 6 is in its closed position shown in Fig. 1a, as is known in the art.

Fig. 2 shows the housing 6 in greater detail. A conduit 24 made from an elastic material has been introduced into the passageway 18. The conduit 24 is supported in the passage 18 by one or more supports 26 that prevent bulging of the conduit 24 between two fingers 20 in the extended state. The supports 26 also prevent lateral movement of the conduit 24 in the passageway 18 during operation of the pump. The cross sectional shape of the passageway 18 is determined by the shape of holes 59 in the supports 26

Fig. 3 shows the pump 2 with a conduit 24 in the passageway 18 in its closed position shown also in Fig. 1a. As can be seen, the fingers 20a and 20c are in their extended position and therefore constrict the conduit 24 and the points of contact 25a and 25c. As explained above, the valves 16 are operated by the processor 22 so that the fingers 20 alternate between their retracted and extended positions so as to generate a flow in the conduit 24

The housing 6 includes an anti-free flow mechanism 39. The anti-free flow mechanism prevents the flow of fluid in the conduit 24 when the housing 6 is not in its closed position shown in Fig. 1a. The anti-free flow mechanism is shown in Fig. 4 in a cross section AA' of the pump 2 shown in Fig. 3. The housing 6 is shown in its open position in Fig. 4a and in its closed position in Fig. 4b. The anti-free flow includes an occlusion plate 32, from which an actuating tab 34 extends (see also Figs. 1 and 2). The occluding plate 32 has a D-shaped hole 36 having a straight bottom edge 37 and an upper arcuate edge 35. A hole 59 of the passageway 18 is indicated in Fig. 4 by a broken line. The holes 59 of the passageway 18 are "D" shaped, having a straight upper edge 41 and an arcuate lower edge 47. The occluding plate is slidable from an obstructing

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position shown in Fig. 4a and a non-obstructing position shown in Fig. 4b. The occluding plate 32 is spring biased in its obstructing position by means of springs 38. In its non-obstructing position (Fig. 4b), the hole 36 of the occlusion plate 32 is essentially aligned with the passageway 18 so that the conduit 24 is unobstructed. In its obstructing position (Fig. 4a), the hole 36 and the passageway 18 only partially overlap, so that the conduit 24 is collapsed between the straight edge 37 of the hole 36 and the straight edge 41 of the passageway 18. The conduit 24 is thus obstructed, as shown in Fig. 4a. This prevents unintentional flow of fluid in the conduit 24 when the housing 6 is swung out from the body 4.

When the housing 6 is swung out from the body 4, the obstructing plate 32 may be brought into its non-obstructing position (Fig. 4b) by manually depressing the tab 34. The tab 34 may be temporarily latched with the plate 32 in its non-obstructing position. This may be done for example, when it is desired to allow free flow of fluid in the conduit. The plate 32 in its latched non-obstructing position is shown in a side view in Fig. 4c. Extensions 51 on either side of the tab 34 (see also Figs. 4a and 4b) are lodged under extensions 53 of the inner wall of the housing 6. The obstructing plate 32 is brought into its latched non-obstructing position (Fig. 4a) from its unlatched non-obstructing position (Fig. 4b) by rotating the plate 32 so as to lodge the extensions 51 under the extensions 53. An upwards pressure on the plate 32 by the springs 38 presses the extensions 51 onto the extensions 53 so as to maintain the anti-free-flow mechanism in its latched non-obstructing state. The obstructing plate 32 may be manually released from its lodged, non-obstructing position by rotating the plate 32 back so as to dislodge the extensions 51 from under the extensions 53. The plate 32 then passes through a slot 57 in the housing 6 in order to regain its obstructing position (Fig. 4a) under the influence of the spring 38. The housing 6 is then swung shut onto the body 4 (Fig. 4b). If the anti-free flow mechanism is in its latched non-obstructing position when the housing is swung onto the body 4, a pair of wedges 55 extending from the body 4 (Fig. 1b) rotate the plate 32 as the

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housing 6 is being swung shut so as to dislodge the extensions 51 from under the extensions 53. A static plate 40 fixed in the body 4 depresses the tab 34 against the spring 38 so to maintain the plate 32 in its unlatched non-obstructing position when the housing 6 is in its closed position.

5           Fig. 5 shows a finger-type peristaltic pump 2' in accordance with another embodiment of the invention. Components of the pump 2' similar to components of the pump 2 are designated by the same reference numerals without further comment. The pump 2' has a body 4' and a housing 6'. The housing 6' is reversibly attachable to the body 4' by means of projections 10' located at both  
10       ends of the housing 6' that snap into mated notches 12' on opposite sides of the body 4'. In Fig. 5a, the housing 6' is shown attached to the body 4', and in Fig. 5b, the housing 6' is shown detached from the body 4'. The pump 2' is operated as described above in reference to the pump 2. The housing 6' may be disposable.

15           Fig. 6 shows a housing 6'' that may be used with the body 4' instead of the housing 6'. Components of the housing 6'' similar to components of the housing 6' are designated by the same reference numerals without further comment. The housing 6'' is integral with an elastic conduit 24'. The conduit 24' is provided at one end with a connector 42 suitable for forming a fluid  
20       connection with an upstream fluid reservoir, such as an infusion bag (not shown). The other end of the conduit 24' is provided with a connector 45 for forming a fluid connection with a downstream device, such as a needle (not shown).

          Fig. 7 shows a housing 6''' that may be used with the body 4' instead of the housing 6'. Components of the housing 6''' similar to components of the  
25       housing 6' are designated by the same reference numerals without further comment. The housing 6''' is integral with an elastic conduit 24''. The conduit 24'' is integral with an upstream fluid reservoir, such as an infusion bag 44. The other end of the conduit 24'' is provided with a connector 45' for forming a fluid connection with a downstream device, such as a needle (not shown).



**CLAIMS:**

1. A finger-type peristaltic pump comprising a body and a housing, the body containing two or more finger-type valves and a processor configured to operate the valves according to a predetermined temporo-spatial pattern, the housing having a passageway configured to receive a conduit, the housing having a first position in which a conduit in the passageway is positioned adjacent to the valve fingers, and a second position in which a conduit in the passageway is not adjacent to the valve fingers.
2. The pump according to Claim 1 wherein the housing is hinged to the body and swings around a hinge between the first position and the second position.
3. The pump according to Claim 1 or 2 wherein the housing is detachable from the body.
4. The pump according to any one of the previous claims wherein the housing comprises an anti-free flow device.
5. The pump according to any one of the previous claims wherein the housing comprises supports preventing bulging of a conduit in the passageway.
6. The pump according to Claim 3 wherein the housing is disposable.
7. A housing for use in the pump of Claim 3.
8. The housing according to Claim 7 wherein the housing comprises an anti-free flow device.
9. The housing according to Claim 8 wherein the anti-flow device has an obstructing state, an unlatched non-obstructing state and a latched non-obstructing state.
10. The housing according to Claim 8 or 9 wherein the anti free flow device is configured to prevent flow in two directions in a conduit when the anti-free flow device is in an obstructing state.

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11. The housing according to Claim 8 or 9 wherein the anti free flow device is configured to prevent flow in one direction in a conduit when the anti-free flow device is in an obstructing state.
12. The housing according to any one of Claims 7 to 11 wherein the housing  
5 comprises supports preventing bulging of a conduit in the passageway.
13. The housing according to any one of Claims 7 to 12 wherein the housing is disposable.
14. The housing according to any one of Claims 7 to 13 wherein the housing is integral with a conduit.
- 10 15. The housing according to Claim 14 wherein the conduit is provided at an end with a connector for forming a fluid connection with a fluid reservoir.
16. The housing according to Claim 15 wherein the fluid reservoir is an infusion bag.
17. The housing according to any one of Claims 14 to 16 wherein the  
15 housing is provided at an end with a connector for forming a fluid connection with a downstream device.
18. The housing according to Claim 17 wherein the downstream device is a needle.
19. The housing according to any one of Claims 14 to 18 wherein the  
20 conduit is integral with a fluid reservoir.
20. The housing according to Claim 19 wherein the fluid reservoir is an infusion bag.
21. The housing according to Claim 19 or Claim 20 wherein the conduit is provided at an end with a connector for forming a fluid connection with a  
25 downstream device.
22. The housing according to Claim 21 wherein the downstream device is a needle.

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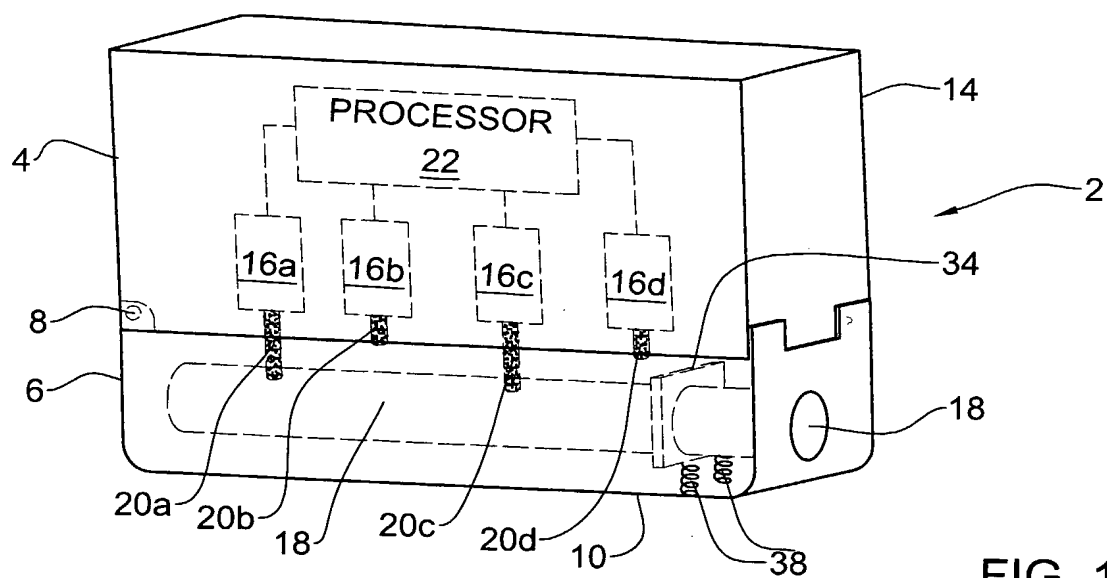


FIG. 1A

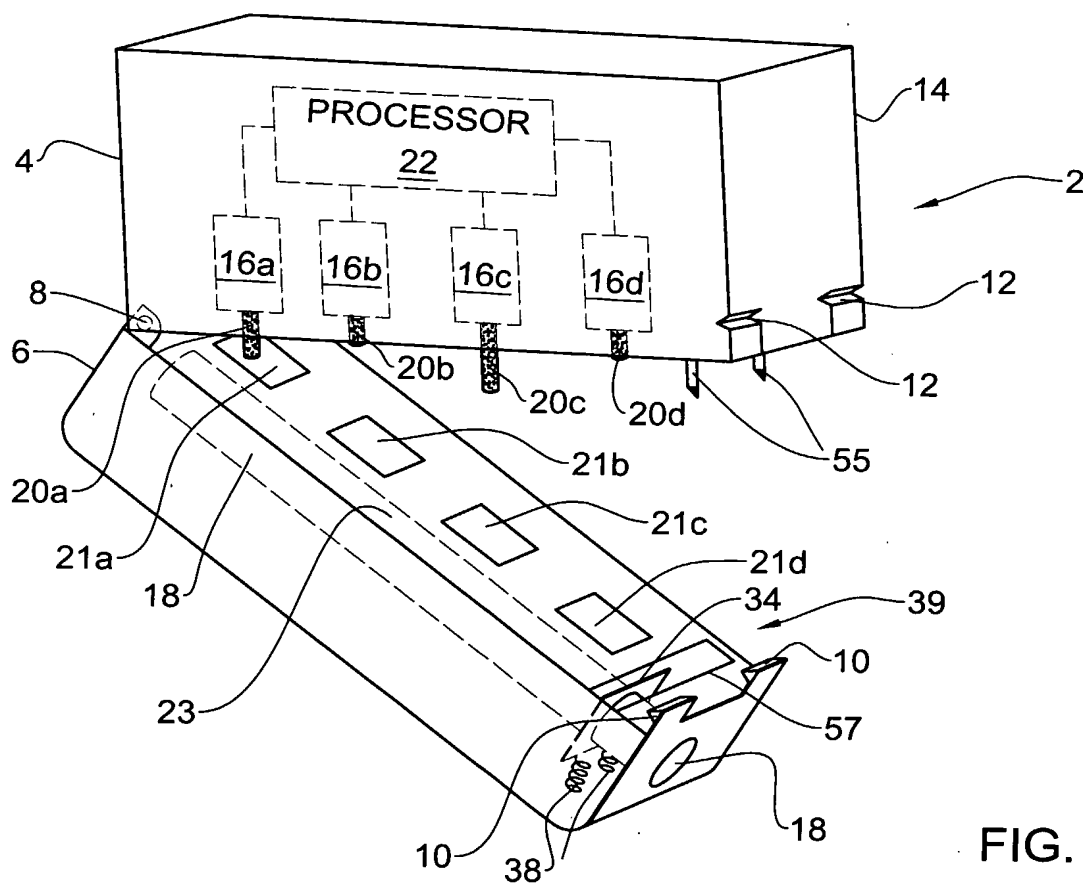


FIG. 1B

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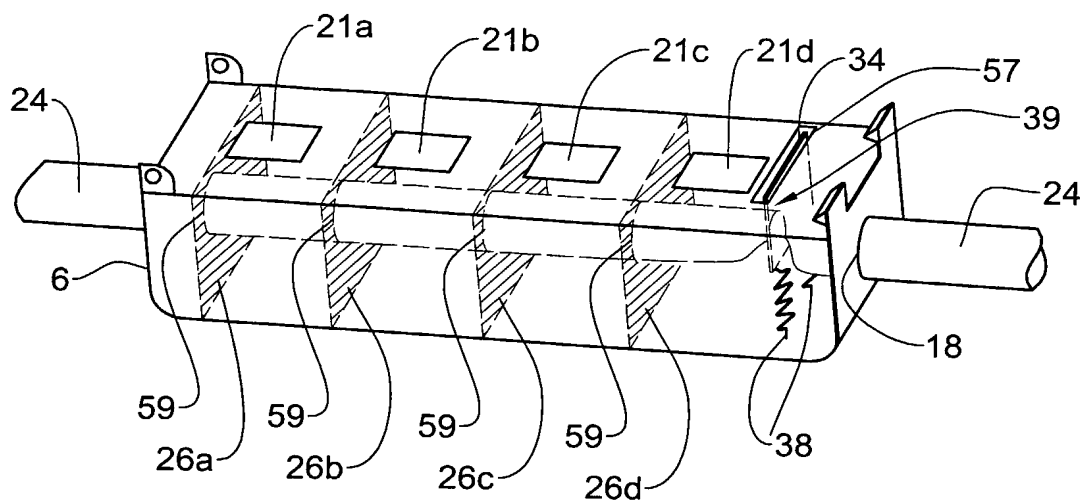


FIG. 2

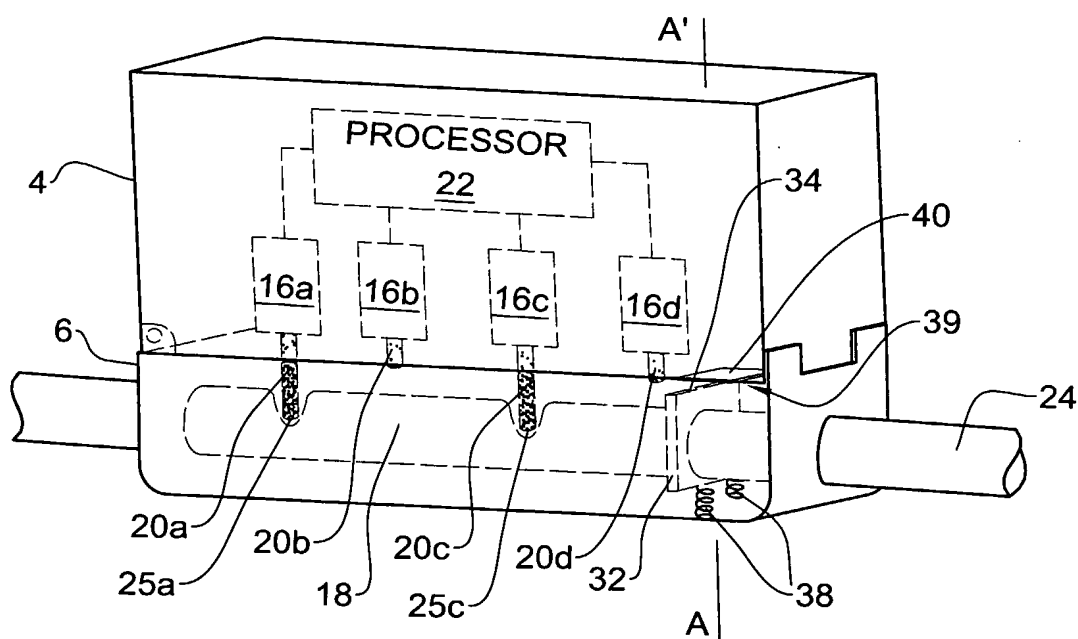


FIG. 3

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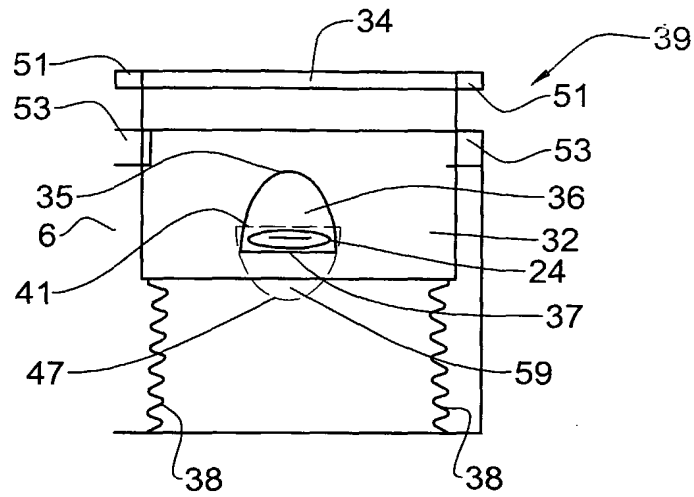


FIG. 4A

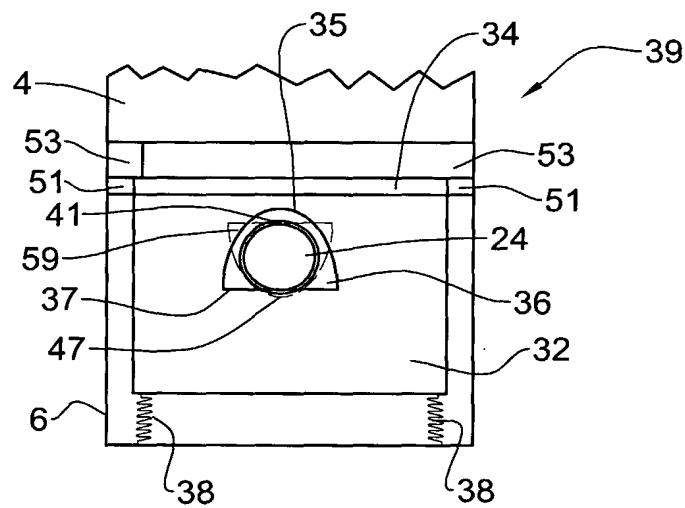


FIG. 4B

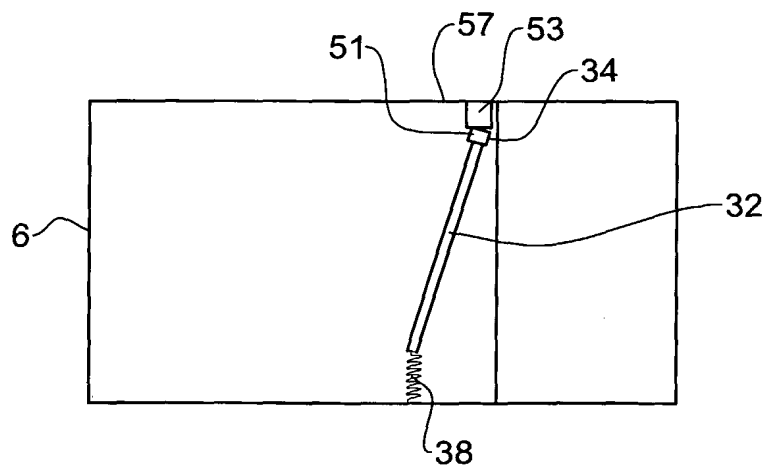


FIG. 4C

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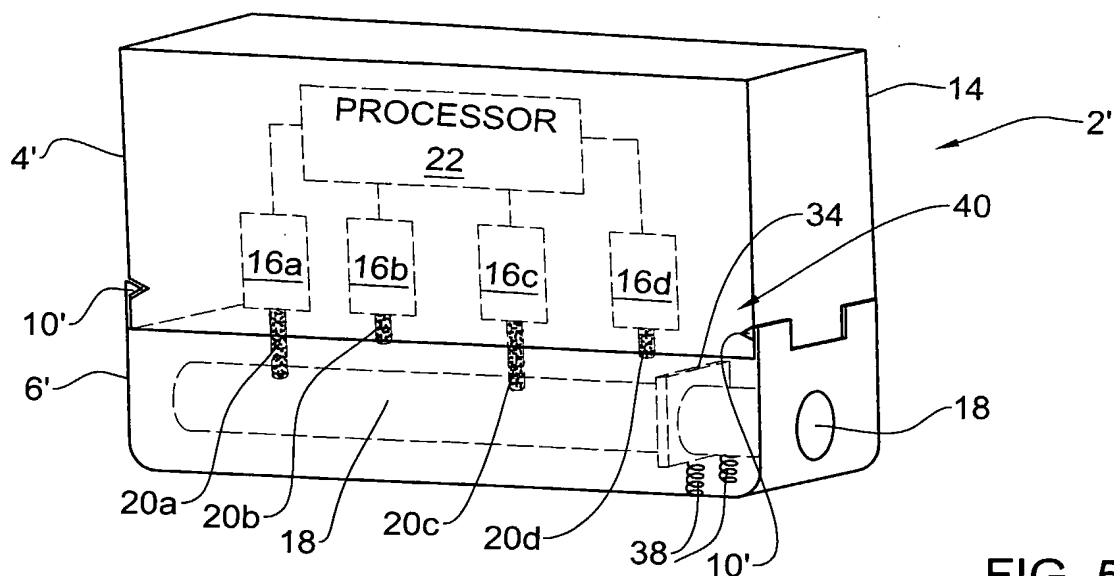


FIG. 5A

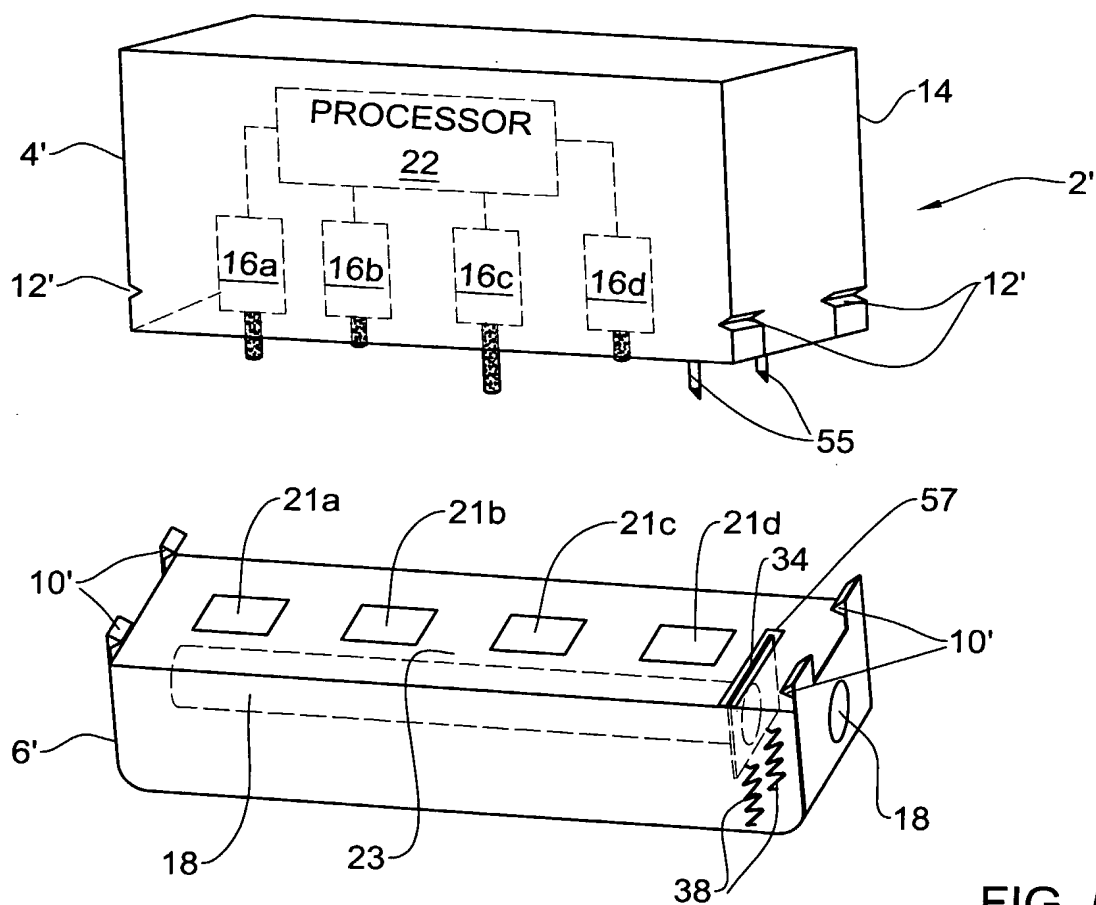


FIG. 5B

FIG. 6

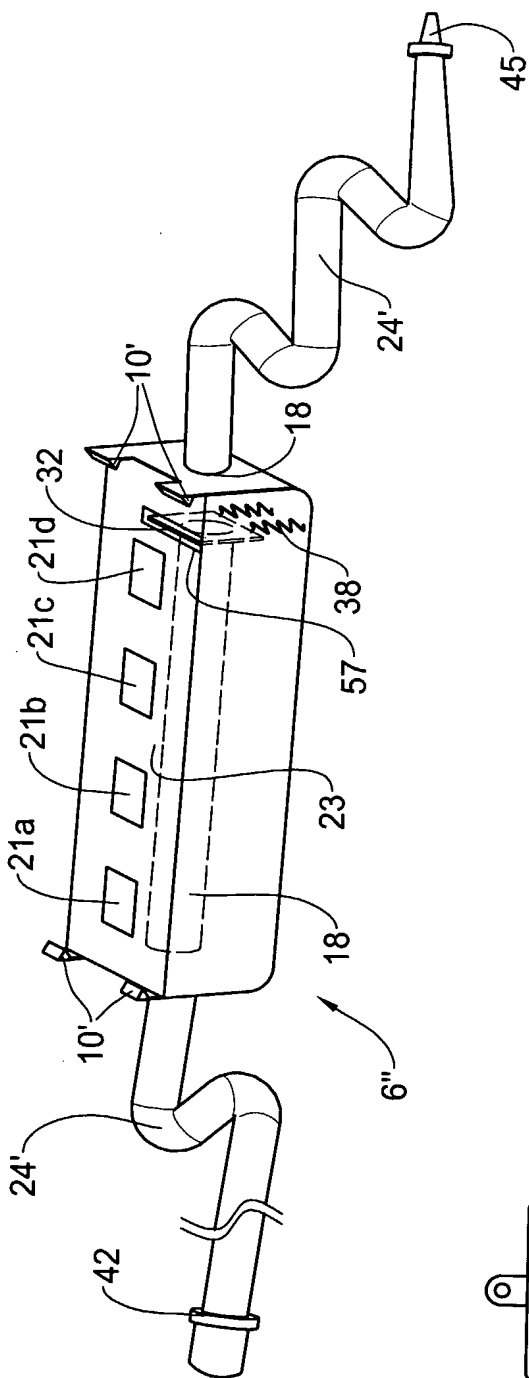
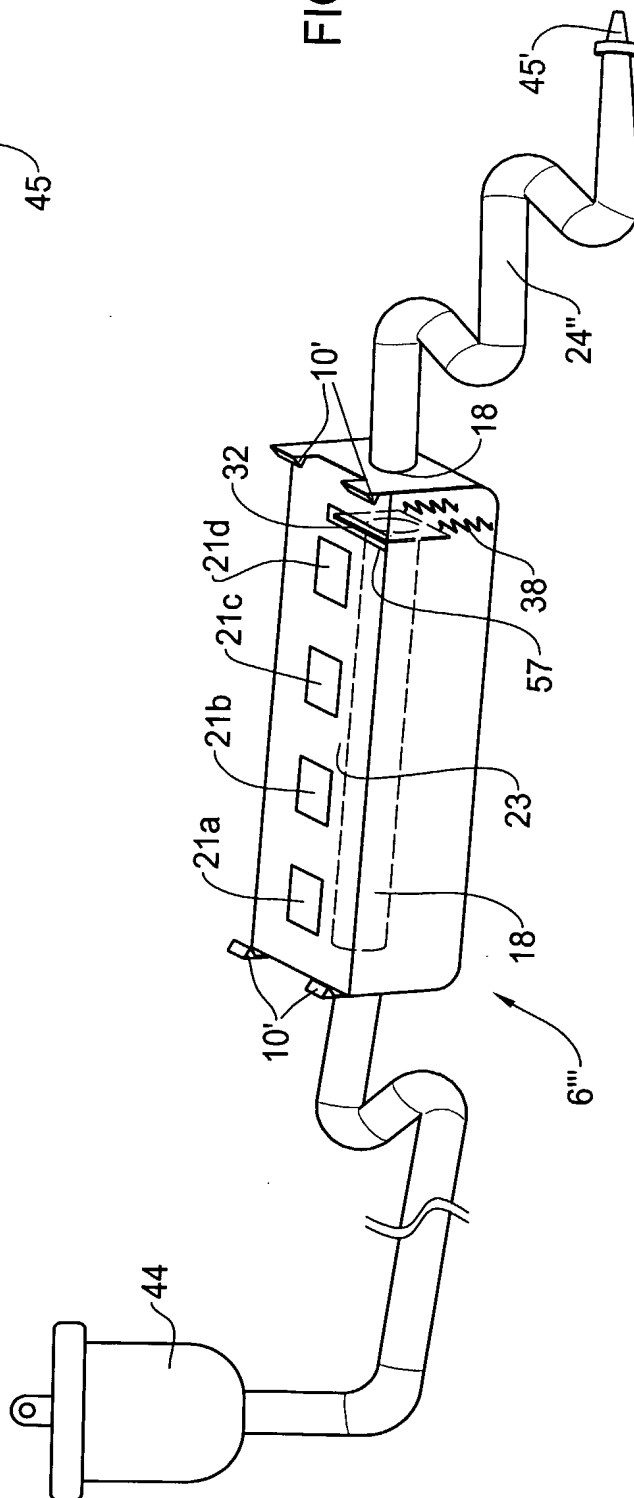


FIG. 7



# INTERNATIONAL SEARCH REPORT

International application No

PCT/IL2005/001249

**A. CLASSIFICATION OF SUBJECT MATTER**  
F04B43/00 A61M5/142

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61M F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of Box C.

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Date of the actual completion of the international search

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# INTERNATIONAL SEARCH REPORT

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## C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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